Claims

1. An ICPT pick-up having a pick-up resonant circuit including a capacitive element and an inductive element adapted to receive power from a magnetic field associated with a primary conductive path to supply a load, sensing means to sense a condition of the load, and control means to selectively tune or de-tune the pick-up in response to the load sensed by the sensing means by varying the effective capacitance or inductance of the pick-up circuit to control the transfer of power to the pick-up dependant on the sensed load condition.

2. A pick-up as claimed in claim 1 wherein the control means includes a reactive element and a switching means to allow the reactive element to be selectively electrically connected to the pick-up circuit.

3. A pick-up as claimed in claim 2 wherein the control means is operable to control the switching means so that the apparent capacitance or inductance of the reactive element is varied to thereby tune or detune the pick-up circuit.

4. A pick-up as claimed in any one of claims 1 to 3 wherein the sensing means senses the power required by the load.

5. A pick-up as claimed in any one of claims 2 to 4 including phase sensing means to sense the phase of a voltage or current in the resonant circuit whereby the control means may actuate the switching means to allow the reactive element to be electrically connected to or disconnected from the resonant circuit dependant on the sensed phase.

6. A pick-up as claimed in claim 5 wherein the reactive element comprises an inductor, the phase sensing means senses a voltage in the resonant circuit and the switch control means is operable to switch the switching means to electrically connect or disconnect the inductor to or from the resonant circuit a predetermined time period after a sensed voltage zero crossing.

7. A pick-up as claimed in claim 4 or claim 5 including frequency sensing means to sense the frequency of the resonant circuit whereby the control means may actuate the switch means to allow the reactive element to be electrically

connected to or disconnected from the resonant circuit dependant on the sensed frequency to alter the natural resonant frequency of the resonant circuit.

8. A pick-up as claimed in claim 4 or claim 5 wherein the phase sensing means sense the frequency of the resonant circuit whereby the control means may actuate the switch means to allow the reactive element to be electrically connected to or disconnected from the resonant circuit dependant on the sensed frequency to alter the natural resonant frequency of the resonant circuit.

9. A pick-up as claimed in any one of claims 6 to 8 wherein the control means is adapted to activate the second switching means to connect the inductor to the resonant circuit after the predetermined time period following a voltage zero crossing has elapsed, and allow the switching means to be deactivated when the voltage again reaches substantially zero.

10. A pick-up as claimed in any one of claims 6 to 9 wherein the control means is capable of varying the predetermined time period between substantially 0 electrical degrees and substantially 180 electrical degrees.

11. A pick-up as claimed in any one of claims 6 to 9 wherein the control means is capable of varying the predetermined time period between substantially 90 electrical degrees and substantially 150 electrical degrees.

12. A pick-up as claimed in any one of claims 6 to 11 wherein the inductor is connected in parallel with a tuning capacitor of the resonant circuit.

13. A pick-up as claimed in any one of claims 6 to 12 wherein the inductor has two terminals and the second switching means comprise two controllable semiconductor switching elements, one switching element being connected between each terminal and the resonant circuit.

14. A pick-up as claimed in claim 13 wherein each switching element has an anti-parallel diode connected thereacross.

15. A pick-up as claimed in claim 13 or claim 14 wherein the semiconductor switch elements comprise IGBT's, MOSFETS, MCT's, BJT's or other semiconductor

devices.

~~15.~~16. A pick-up as claimed in claim 3 wherein the inductor comprises the pick-up coil.

17. A pick-up as claimed in claim 5 wherein the reactive element comprises a capacitor, the phase sensing means senses a voltage in the resonant circuit, and the switch control means is operable to switch the switching means to electrically connect or disconnect the capacitor to or from the resonant circuit a predetermined time period after a sensed voltage zero crossing.

18. A pick-up as claimed in claim 17 including frequency sensing means to sense the frequency of the resonant circuit whereby the control means may actuate the switch means to allow the reactive element to be electrically connected to or disconnected from the resonant circuit dependant on the sensed frequency to alter the natural resonant frequency of the resonant circuit.

19. A pick-up as claimed in claim 17 wherein the phase sensing means sense the frequency of the resonant circuit whereby the control means may actuate the switch means to allow the reactive element to be electrically connected to or disconnected from the resonant circuit dependant on the sensed frequency to alter the natural resonant frequency of the resonant circuit.

20. A pick-up as claimed in any one of claims 17 to 19 wherein the control means is adapted to activate the switching means to disconnect the capacitor from the resonant circuit after the predetermined time period following a voltage zero crossing has elapsed.

21. A pick-up as claimed in any one of claims 17 to 20 wherein the control means is capable of varying the predetermined time period between substantially 0 electrical degrees and substantially 90 electrical degrees.

22. A pick-up as claimed in any one of claims 17 to 22 wherein the capacitor is connected in parallel with a tuning capacitor of the resonant circuit.

23. A pick-up as claimed in claim 23 wherein the capacitance of the capacitor is substantially equal to the capacitance of the tuning capacitor.

24. A pick-up as claimed in any one of claims 17 to 24 wherein the capacitor has two terminals and the switching means comprise two controllable semiconductor switching elements, one switching element being connected between each terminal and the resonant circuit.

25. A pick-up as claimed in claim 25 wherein each switching element has an anti-parallel diode connected thereacross.

26. A pick-up as claimed in claim 25 or claim 26 wherein the semiconductor switch elements comprise IGBT's, MOSFETS,or BJT's.

27. A pick-up as claimed in any one of claims 17 to 21 wherein the variable reactance comprises the tuning capacitor of the resonant circuit.

28. An ICPT system including:

a. A power supply comprising a resonant converter to provide alternating current to a primary conductive path of the ICPT system;
b. One or more secondary pick-ups, each pick-up having a pick-up resonant circuit including a capacitive element and an inductive element adapted to receive power from a magnetic field associated with a primary conductive path to supply a load, sensing means to sense a condition of the load, and control means to selectively tune or de-tune the pick-up in response to the load sensed by the sensing means by varying the effective capacitance or inductance of the pick-up circuit to control the transfer of power to the pick-up dependant on the sensed load condition.

29. An ICPT system as claimed in claim 28 wherein the primary conductive path comprises one or more turns of electrically conductive material.

30. An ICPT system as claimed in claim 29 wherein the primary conductive path is provided beneath a substantially planar surface.

31. An ICPT system as claimed in claim 28 wherein the primary conductive path includes at least one region about which there is a greater magnetic field strength than one or more other regions of the path.

32. An ICPT system as claimed in claim 28 wherein the primary conductive path includes one or more lumped inductances or one or more distributed inductances.

33. An ICPT system as claimed in any one of claims 28 to 32 wherein the primary conductive path is mounted adjacent to an amorphous magnetic material to provide a desired magnetic flux path.

34. An ICPT system as claimed in any one of claims 28 to 33 wherein the pick-up includes an amorphous magnetic material adjacent to the pick-up coil to provide a desired magnetic flux path.

35. An ICPT system as claimed in any one of claims 28 to 34 wherein the pick-up is battery-free.

36. An ICPT system as claimed in any one of claims 28 to 34 wherein the pick-up includes a super-capacitor.

37. A method for controlling power drawn by an ICPT pick-up, the method including the steps of sensing a load condition of the pick-up, and selectively tuning or detuning the pick-up circuit depending upon the sensed load condition.

38. A method as claimed in claim 37 wherein the step of tuning or detuning the pickup circuit includes moving the resonant frequency of the pick-up circuit toward or away from a tuned condition.

39. A method as claimed in claim 37 or claim 38 wherein the step of tuning or detuning the pick-up circuit includes the step of controlling a variable capacitor or inductor.

40. A method as claimed in any one of claims 37 to 39 including the step of sensing the frequency of a current or voltage in the resonant circuit.

41. A method as claimed in claim 40 including the step of comparing the sensed

frequency with a nominal frequency for the resonant circuit and tuning or de-tuning toward or away from the nominal frequency dependant on the sensed load.

42. A method as claimed in any one of claims 37 to 41 including the steps of selectively switching a reactive element into or out of the resonant circuit to alter the apparent inductance or capacitance of the reactive element to thereby tune or de-tune the resonant circuit.

43. A method as claimed in claim 42 including sensing the phase of a voltage or current in the resonant circuit and electrically connecting or disconnecting the reactive element to or from the resonant circuit dependant on the sensed phase.

44. A method as claimed in claim 43 wherein the phase of a voltage is sensed and the reactive element is electrically connected to the resonant circuit a predetermined time period after a sensed voltage zero crossing.

45. A method as claimed in any one of claims 42 to 44 including sensing the frequency of the resonant circuit activating a switching means to electrically connect or disconnect the reactive element to or from the resonant circuit dependant on the sensed frequency to alter the natural resonant frequency of the resonant circuit.

46. A method as claimed in any one of claims 42 to 45 including comparing the sensed frequency with a nominal frequency and varying the predetermined time period to tune the resonant circuit toward or away from the nominal frequency.

47. A method as claimed in any one of claims 42 to 46 including activating a switching means to connect the reactive element to the resonant circuit after the predetermined time period following a voltage zero crossing has elapsed, and allowing the second switching means to be deactivated when the voltage again reaches substantially zero.

48. A method as claimed in any one of claims 42 to 47 including selecting the predetermined time period from a range between substantially 0 electrical

degrees and substantially 180 electrical degrees.

48.49. A method as claimed in any one of claims 42 to 47 including selecting the predetermined time period from a range between substantially 90 electrical degrees and substantially 150 electrical degrees.

50. A method as claimed in claim 43 including sensing the phase of a voltage and electrically disconnecting the reactive element from the resonant circuit a predetermined time period after a sensed voltage zero crossing.

51. A method as claimed in claim 50 wherein the reactive element comprises a capacitor and the predetermined time period is selected from a range between substantially 0 electrical degrees and substantially 90 electrical degrees.

52. A pick-up substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.

53. An ICPT system substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.

54. A method for controlling power substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.